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Blood Chemistry Values for Some Fishes of the Upper Mississippi River

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ABSTRACT — Plasma concentrations of sodium, potassium, calcium, magnesium, chloride, inorganic phosphate, glucose, lactic acid and total carbon dioxide and whole blood pH and hematocrit were determined for nine species of fish from the Upper Mississippi River area. Most of the values obtained fall within the range of values published for other freshwater fishes, except that the plasma concentrations of potassium and chloride in sexually mature walleye pike were low. The chloride was compensated for by a high plasma total carbon dioxide. Further studies should establish whether these blood chemistry values may be considered of normal range.
counties.

"He paused and stood for a moment in silence, drumming with his fingers on the glass of the aquarium. Poised between mud and air, the two obese and aged carp hung in their greenish twilight, serenely unaware of him. Dr. Obispo shook his head. The worst experimental animals in the world, he said. Nobody has a right to talk about technical difficulties who hadn't tried to work with fish. The simplest operation was a nightmare. Had you ever tried to keep its gills properly wet while it was anesthetized on the operating table? Or, alternately, to do your surgery under water? Had you ever set out to determine a fish's basal metabolism, or take an electrocardiogram of its heart action, or measure its blood pressure? Had you ever wanted to analyze its excreta? And, if so, did you know how hard it was even to collect them? Had you ever attempted to study the chemistry of a fish's digestion and assimilation? To measure the speed of its nervous reactions?

"No, you had not, said Dr. Obispo contemptuously, and until you had, you have no right to complain about anything."

Huxley (1937), speaking through Dr. Obispo, was certainly correct in his assessment of fish as an experimental animal. However, great strides have been in the last ten years in the study of fishes. A reading of the volumes on Fish Physiology edited by Hoar and Randall (1969, 1970) would convice Dr. Obispo that we have made good progress in studies on the physiology and biochemistry of fishes.

One real deficiency in knowledge of fishes relates to their blood chemistries. A few studies, mainly with intensively cultured species, have been done to establish the range of normal blood chemistry values (Barnhart, 1969; Wedemeyer and Chatterton, 1970). The present study was undertaken to establish blood chemistry parameters for some sport and commercial species found in local waters as well as for two interesting but sometimes undesirable species, the shortnose gar and bowfin.

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Specimens and procedures used

The shortnose gar (*Lepisosteus platostomus*), bowfin (*Amia calva*), northern pike (*Esox lucius*), spotted sucker (*Minytrema melanops*), yellow bullhead (*Ictalurus natalis*), and walleye (*Stizostedion vitreum*) were trapped from the Mississippi River during April, 1971, in the vicinity of the National Fish Hatchery at Genoa, Wisconsin. All northern pike and walleye sampled were ripe males. All other fish used in this study were sexually mature but not ripe. Brown trout (*Salmo trutta*) and albino brook trout (*Salvelinus fontinalis*) were from the National Fish Hatchery at Manchester, Iowa, and carp (*Cyprinus carpio*) were from the National Fish Hatchery at Lake Mills, Wisconsin. All fish were transported to the Fish Control Laboratory and maintained there according to the methods outlined by Hunn et al. (1968). Fish were held for a minimum of one week before blood samples were taken.

Heparinized blood samples were drawn between 8 and 10 a.m. by caudal peduncle puncture (Steucke and Schoettger, 1967) without anesthesia. Syringes were then placed on ice or refrigerated until the samples for pH and total carbon dioxide could be processed. The blood was then centrifuged and the plasma drawn off for further analysis. Whole blood pH and pO_2 were measured using an Instrumentation Laboratories ultra-micro pH and blood gas analyzing system and an IL model 125A, portable, polarographic analyzer thermostatically regulated at 12° C.

Plasma samples were diluted with a 0.5-percent lanthanum solution and concentrations of sodium, potassium, magnesium, and calcium determined by atomic absorption spectroscopy. Concentrations of chloride and inorganic phosphate in the plasma were measured by methods given by Hunn (1969). The total carbon dioxide in plasma was measured with a Natelson microgasmeter. Lactic acid concentrations were estimated by the enzymatic method given by Grant et al. (1970). The Glucostat (Worthington Biochemical Corporation, Freehold, N.J.) method was used to measure plasma glucose.

Range of values

Most of the concentrations of the inorganic ions for the nine species of fish presented in Table 1 fall within

the range of values for freshwater fish tabulated by Holmes and Donaldson (1969) and Grant et al. (1970). The only exception is walleye which had low concentrations of potassium and chloride compared with the other species. Ripe, male walleye are known to have high concentrations of potassium in the seminal plasma (Gregory, 1970). The plasma potassium is most likely the source of that chemical in the seminal fluid, as suggested by Grant et al. (1969). Apparently the low levels of chloride are compensated by the higher than normal bicarbonate concentrations (see total CO_2, Table 2). This hypokalemia is probably associated with the handling stress encountered in this species by fishery workers during spawning operations.

Blood glucose concentrations measured in these nine species fall within the range of values summarized by Chavin and Young (1970). Although the concentration reported in Table 2 for yellow bullheads is low compared with the other species, it appears to be comparable with data from other Ictalurids (Chavin and Young, 1970).

Blood samples taken via caudal peduncle puncture usually yield venous or mixed samples; therefore, the low partial pressures recorded for oxygen (pO_2) were not unexpected. Garey (1967) recorded venous blood pO_2's for carp that averaged 3.2 mmHg (range 1 to 10).

Hematocrit values obtained in this study agree with those recorded by Hunn et al. (1968). All values presented in this study represent but one point in time in the diurnal as well as the seasonal cycle of these fishes, and further studies are suggested to establish whether these blood chemistry values fall within the range that is considered normal.

TABLE 1. – Concentrations in the plasma of nine species of freshwater fishes.

SPECIES	Na meq/1	K meq/1	Ca meq/1	Mg meq/1	Cl meq/1	PO_4 mg/100 ml
Shortnose gar	139.2 (10)[1] ± 2.4	2.18 (10) ± .29	5.16 (10) ± .49	1.84 (10) ± .17	114.3 (10) ± 1.6	12.71 (10) ± 2.18
Bowfin	143.1 (9) ± 2.5	2.33 (9) ± .41	4.76 (9) ± .31	2.01 (9) ± .14	120.3 (9) ± 4.0	15.58 (10) ± 2.32
Brown trout	155.5 (10) ± 5.2	2.18 (10) ± .29	5.14 (10) ± .40	1.51 (10) ± .17	108.6 (9) ± 6.9	31.69 (10) ± 3.23
Brook trout	148.0 (8) ± 5.6	2.17 (8) ± .14	4.71 (8) ± .27	1.51 (8) ± .20	108.6 (8) ± 1.6	25.32 (8) ± 1.38
Northern Pike	132.3 (10) ± 7.3	1.77 (9) ± .96	4.96 (10) ± .41	1.52 (10) ± .48	104.8 (9) ± 4.3	27.20 (10) ± 4.89
Carp	131.3 (10) ± 7.0	2.83 (10) ± .67	3.97 (10) ± .53	1.96 (10) ± .10	103.7 (9) ± 6.2	16.22 (9) ± 3.02
Spotted sucker	130.5 (9) ± 5.7	2.05 (9) ± .58	6.36 (9) ± 2.02	2.62 (9) ± .36	103.6 (9) ± 10.0	17.10 (9) ± 3.07
Yellow bullhead	134.3 (10) ± 1.4	2.67 (10) ± .36	5.31 (10) ± 1.19	1.86 (10) ± .11	113.3 (10) ± 3.9	18.77 (10) ± 4.00
Walleye	135.8 (9) ± 9.3	0.89 (9) ± .79	4.76 (9) ± .39	1.91 (9) ± .27	62.0 (6) ± 10.5	30.91 (9) ± 6.85

[1] Mean ± SD with the number of fish sampled in parenthesis

TABLE 2. – Concentrations in the plasma and the pH, partial pressure of oxygen, and hematocrit of whole blood.

SPECIES	Glucose mg/100 ml	Lactic Acid mg/100 ml	Total CO_2 Vol. %	pH	pO_2 mmHg	Hemat. %
Shortnose gar	105.1 (10)[1] ± 18.1	6.23 (10) ± .65	32.24 (10) ± 1.73	7.78 (10) ± .03	15.5 (10) ± 3.0	44 (10) ± 7
Bowfin	31.0 (9) ± 5.2	7.62 (9) ± 4.37	26.18 (9) ± 1.37	7.70 (9) ± .05	10.4 (9) ± 1.7	29 (9) ± 6
Brown trout	52.0 (10) ± 6.5	10.05 (10) ± 15.85	30.85 (10) ± 0.90	7.51 (10) ± .08	16.6 (10) ± 7.7	33 (10) ± 4
Brook trout	59.2 (8) ± 4.3	5.16 (8) ± 1.54	30.49 (8) ± 1.10	7.71 (8) ± .06	17.4 (8) ± 7.7	31 (8) ± 5
Northern Pike	53.4 (10) ± 16.2	24.27 (10) ± 10.77	25.99 (10) ± 1.70	7.64 (9) ± .18	4.9 (9) ± 4.7	30 (10) ± 5
Carp	42.9 (9) ± 7.6	38.50 (9) ± 31.97	37.11 (9) ± 5.97	7.59 (9) ± .12	7.3 (9) ± 4.1	28 (9) ± 5
Spotted sucker	40.4 (9) ± 16.2	23.05 (9) ± 7.35	31.46 (9) ± 4.12	7.64 (9) ± .08	8.6 (9) ± 2.1	36 (9) ± 4
Yellow bullhead	15.7 (10) ± 6.0	11.34 (10) ± 5.36	29.05 (10) ± 2.50	7.65 (10) ± .04	5.1 (10) ± 1.6	31 (10) ± 6
Walleye	152.5 (9) ± 78.3	34.39 (9) ± 11.61	57.23 (10) ± 6.10	7.85 (10) ± .08	6.6 (10) ± 4.0	46 (10) ± 4

[1] Mean ± SD with the number of fish sampled in parenthesis

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BOTANY

Scirpus validus *and* S. acutus — *A Question of Distinctness*

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ABSTRACT — An analysis of 32 populations of bulrushes in the *Scirpus validus-acutus* complex growing in Itasca State Park and prairie ponds to the west indicates that most of the populations are referable to neither *S. validus* nor *S. acutus* but, rather, are intermediate in morphology. Further, the supposedly characteristic features by which the two nomenclatural species have been identified are erratically correlated.

Two widely distributed nomenclatural species of bulrushes, *S. validus* Vahl and S. *acutus* Muhl. are generally recognized. These emergent aquatics not only seem to share similar, if not identical, habitats but also share similar morphological characteristics the ranges of which are barely distinct and in several instances are overlapping. Consequently, although several manuals (e.g., Fassett, 1957; Fernald, 1950; Gleason, 1952; Gleason & Cronquist, 1967; Muenscher, 1944) list *S. validus* and *S. acutus* as distinct, we have been unable to observe the described discontinuity among 32 populations in Lake Itasca and surrounding areas. On the contrary, the populations sampled present a picture of phenotypic intermediacy with key characters, when compared on a paired basis, presenting a very erratic pattern of correlation. The degree of phenotypic intermediacy and erratic nature of correlation between key characters cast serious doubt on the validity of maintaining *S. validus* and *S. acutus* as distinct species even though samples for this study are from a geographical area of relatively restrictive size. A similar conclusion was drawn by Beal & Monson (1954) from a sampling of plants throughout the state of Iowa.

As a means of determining the phenotypic affinity of the bulrushes in Lake Itasca and surrounding areas to *S. validus* & *S. acutus*, 32 populations were sampled. Fourteen of these populations are in Lake Itasca, three in Elk Lake — which drains into Lake Itasca, two in the Mis-

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